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Su et al.

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(54) **WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Wei-Cheng Su**, New Taipei (TW); **Yen-Hui Lin**, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

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(30) **Foreign Application Priority Data**

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H01Q 1/24 (2006.01)
H01Q 1/42 (2006.01)
H01Q 9/42 (2006.01)

(52) **U.S. Cl.**
CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/42*** (2013.01); ***H01Q 9/42*** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/38; H01Q 1/243; H01Q 9/0421
USPC 343/702, 767, 872, 878
See application file for complete search history.

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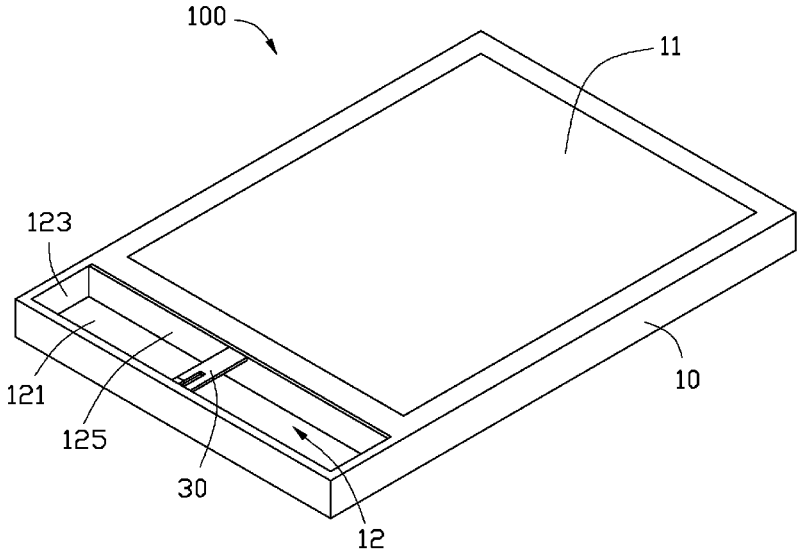
Primary Examiner — Dameon E Levi
Assistant Examiner — Collin Dawkins
(74) *Attorney, Agent, or Firm* — Zhigang Ma

(57) **ABSTRACT**

A wireless communication device includes a housing and an antenna. The housing is made of metal and defines a conductive chamber. The chamber includes a bottom wall, two opposite first side walls, and two opposite second side walls connecting to the first side walls, the first side walls and the second side walls surrounding around the bottom wall. The antenna comprises a radiating body, a feed end, and a ground end. The radiating body is suspended above the chamber and distanced from the conductive chamber in such a way that the antenna functions in a resonance mode with the conductive chamber, in operating at the required frequencies. The feed end and ground end extend from the radiating body and are connected to one of the second side walls.

18 Claims, 7 Drawing Sheets



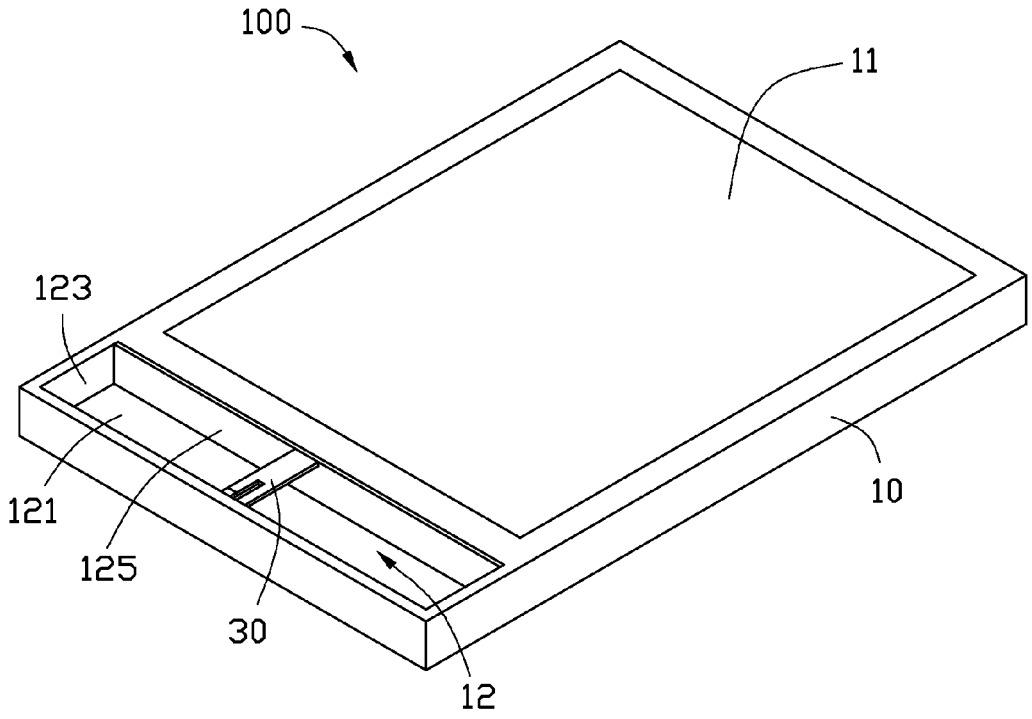


FIG. 1

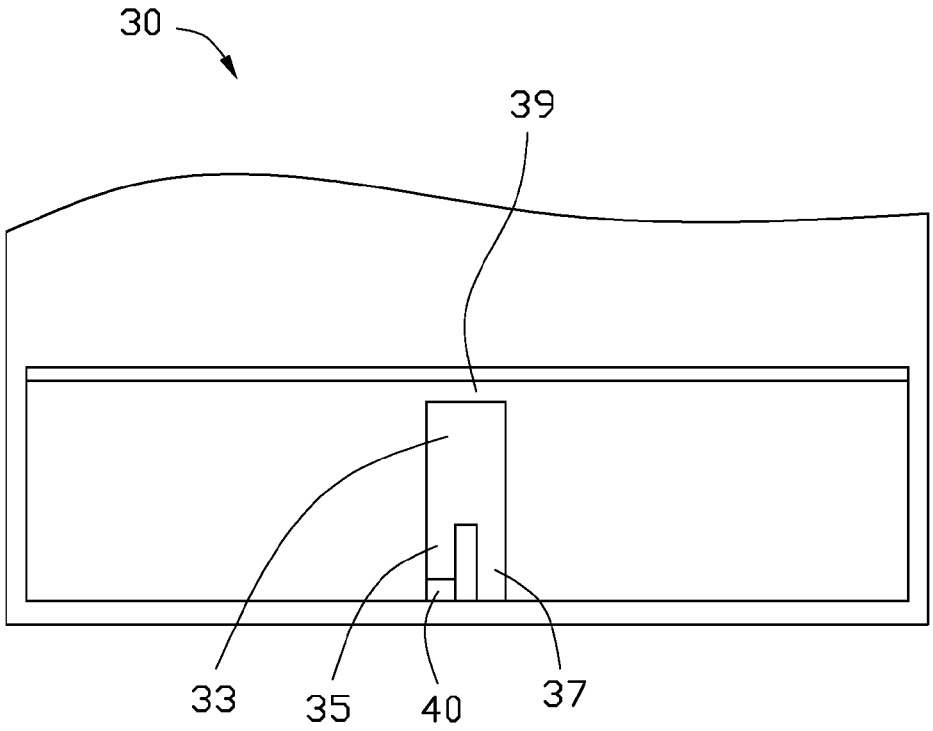


FIG. 2

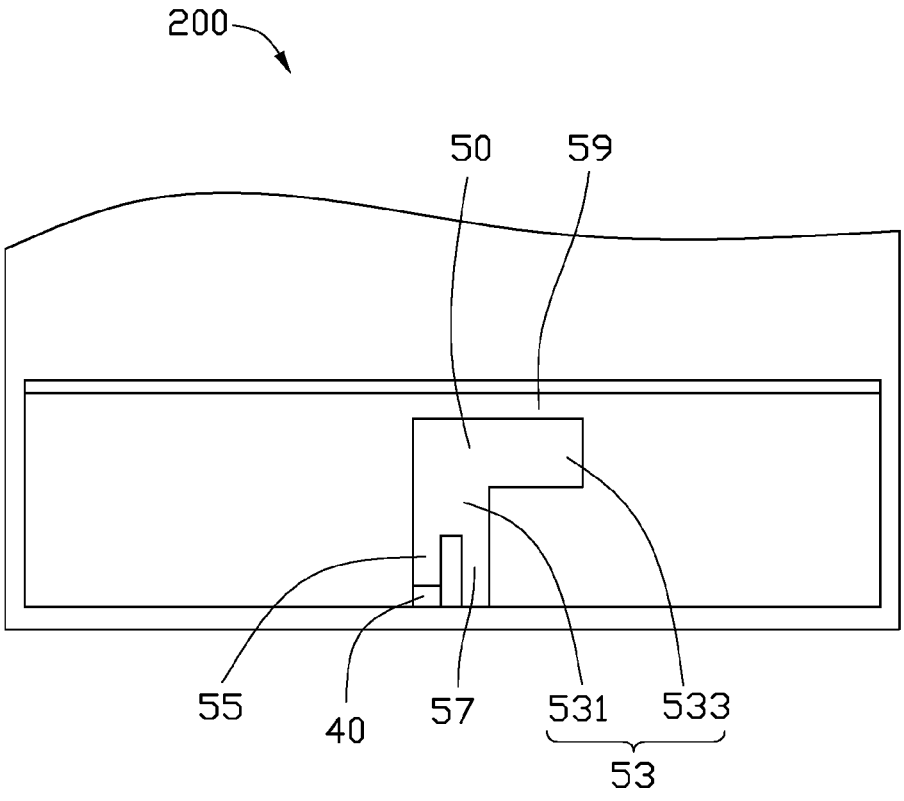


FIG. 3

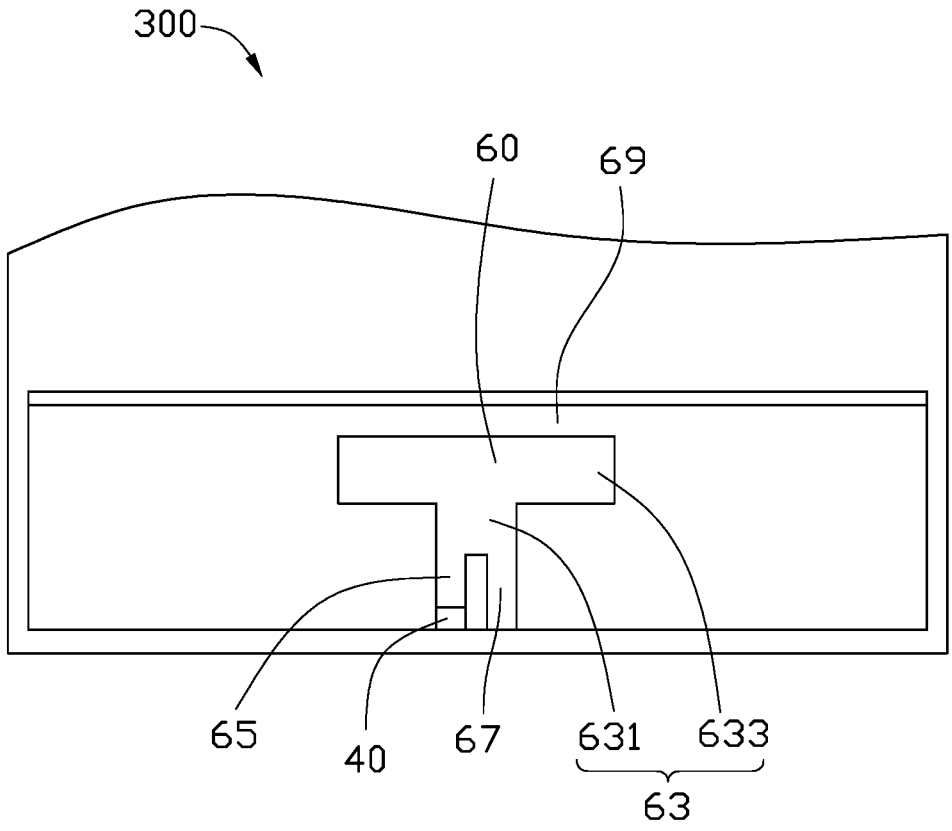


FIG. 4

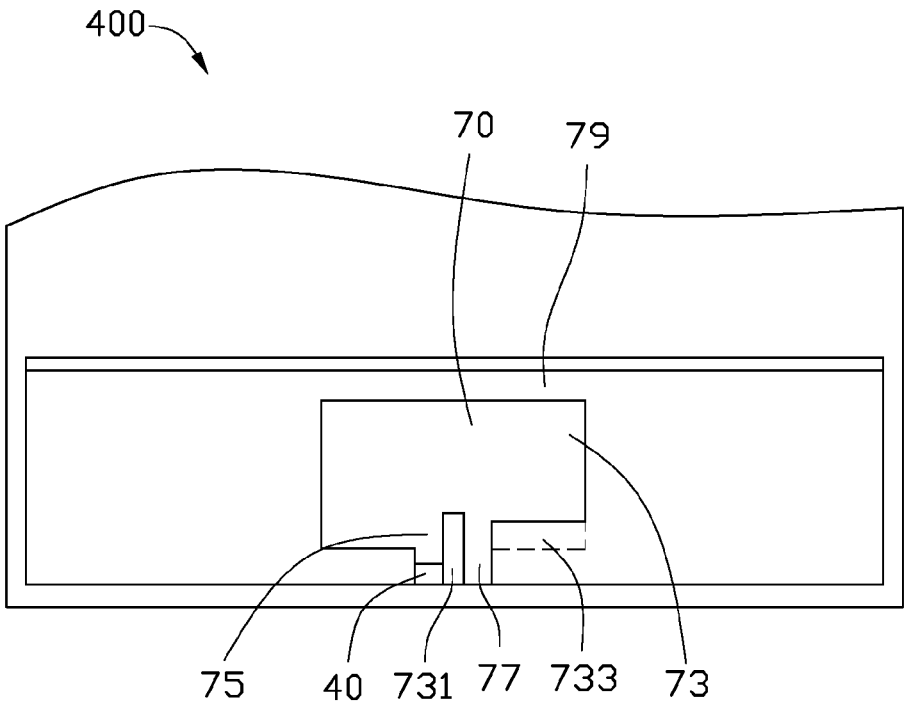


FIG. 5

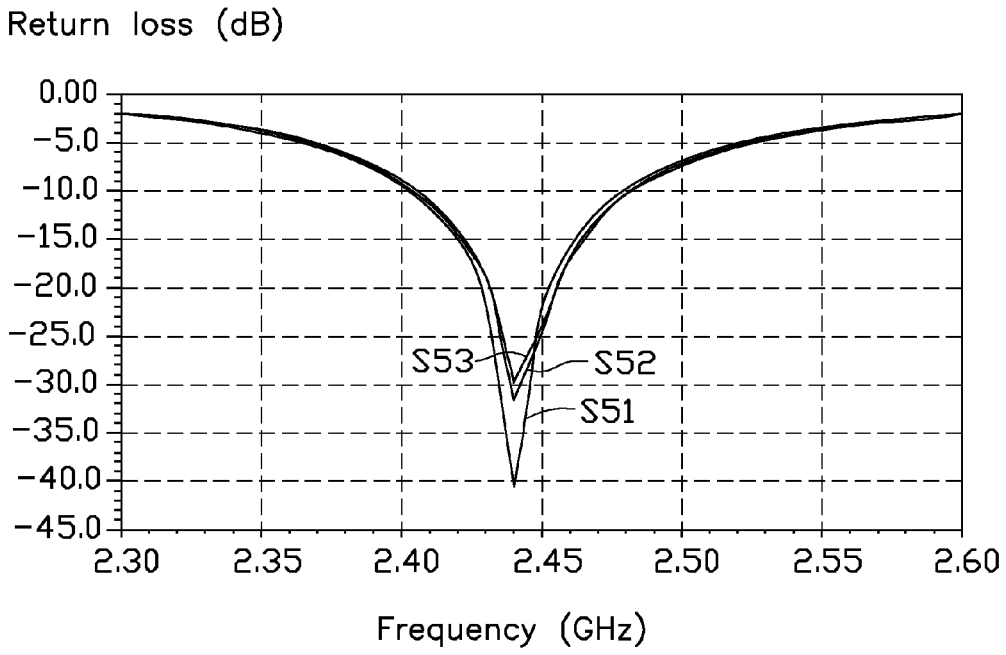

Return loss (dB)
0.00
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
-45.0
2.30
2.35
2.40
2.45
2.50
2.55
2.60
Frequency (GHz)
S53
S52
S51

FIG. 6

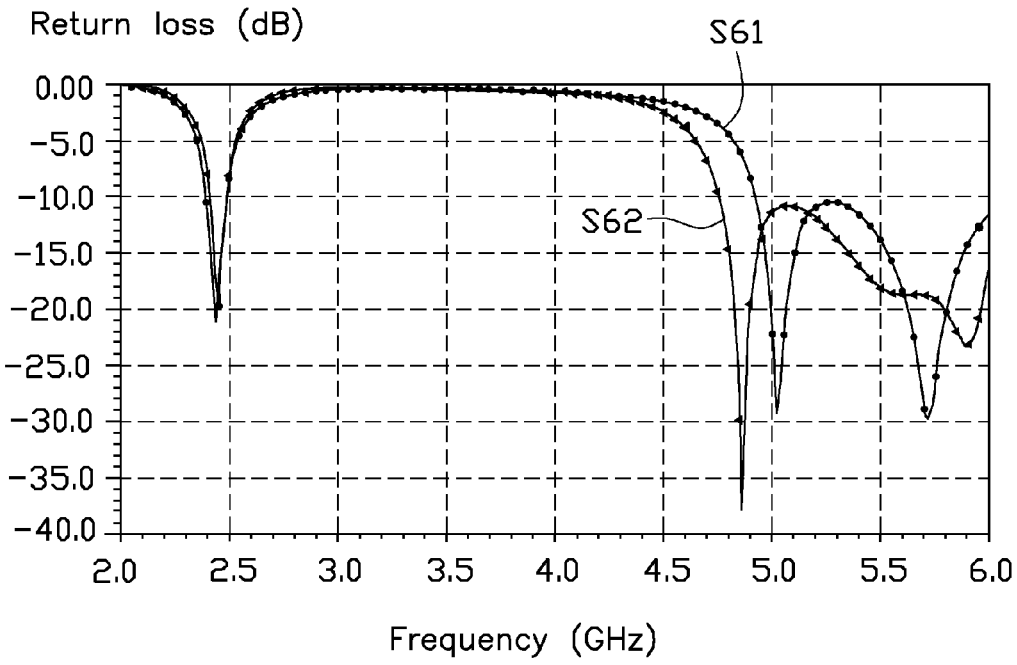

Return loss (dB)
S61
S62
0.00
-5.0
-10.0
-15.0
-20.0
-25.0
-30.0
-35.0
-40.0
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Frequency (GHz)

FIG. 7

WIRELESS COMMUNICATION DEVICE

BACKGROUND

1. Technical Field

The disclosure generally relates to wireless communication devices, and particularly to a wireless communication device having an integrated metal appearance and a better transmitting performance.

2. Description of Related Art

Metal shells are widely used in wireless communication devices because of the advantages of mechanical strength, resistance to deformation, and tactile sensation. However, the metal shells may shield and interfere with signals radiated by antennas of the wireless communications and narrows working frequencies of the antennas.

In a conventional way to reduce the interference, the wireless communication device commonly includes a housing having a non-metal portion (such as a plastic portion) adjacent to the antenna so that the antenna is apart from a metal portion of the housing. However, the joint between the non-metal portion and the metal portion does not have an integrated or seamless appearance.

Therefore, there is room for improvement within the art.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the present disclosure can be better understood with reference to the following drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the disclosure.

FIG. **1** is a schematic view of a wireless communication device having an antenna, according to a first exemplary embodiment of the disclosure.

FIG. **2** is a top view, schematic view of the wireless communication device of FIG. **1**.

FIG. **3** is a top, schematic view of a wireless communication device having an antenna, according to a second exemplary embodiment of the disclosure.

FIG. **4** is a top, schematic view of a wireless communication device having an antenna, according to a third exemplary embodiment of the disclosure.

FIG. **5** is a top, schematic view of a wireless communication device having an antenna, according to a fourth exemplary embodiment of the disclosure.

FIG. **6** is a diagram showing return loss (RL) measurements of the antennas shown in FIGS. **2-4**.

FIG. **7** is a diagram showing return loss (RL) measurements of the antenna shown in FIG. **5**.

DETAILED DESCRIPTION

FIG. **1** is a schematic view of a wireless communication device **100**, according to a first exemplary embodiment of the disclosure. The wireless communication device **100** includes a housing **10** and an antenna **30** positioned in the housing **10**.

The housing **10** is substantially rectangular and made of metal. A screen **11** is positioned on a first end of the housing **10**. A chamber **12** is defined in a second end of the housing **10** adjacent to the screen **10**. The chamber **12** includes a bottom wall **121**, two opposite first side walls **123**, and two opposite second side walls **125** connected to the first side walls **123**. The first side walls **123** and the second side walls **125** surround the bottom wall **121**. A length of each of the second side walls **125** is slightly longer than that of each of the first side walls **123**. In this exemplary embodiment, the chamber **12** is substantially rectangular.

Also referring to FIG. **2**, the antenna **30** is a single-pole antenna including a radiating body **33**, a feed end **35**, and a ground end **37**. The radiating body **33** is made of conductive materials such as a metal sheet or a flexible printed circuit board. In this exemplary embodiment, the radiating body **33** is substantially a rectangular sheet. The feed end **35** and the ground end **37** are both strip-shaped. A length of the feed end **35** is slightly shorter than that of the ground end **37**. The feed end **35** and the ground end **37** extend from a first end of the radiating body **33**, and are parallel and spaced from each other. The feed end **35** is connected to one of the second side walls **125** far away from the screen **11** by a connection member **40**. The connection member **40** may be a coaxial cable. The ground end **37** is directly connected to the other of the second side walls **125**. The radiating body **33** is suspended above a central portion of the chamber **12**. A second end of the radiating body **33** opposite to the feed end **35** and the ground end **37** defines a first gap **39** with the other of the second side walls **125** adjacent to the screen **11**. A width of the first gap **39** can be changed to facilitate the antenna **30** functioning in a resonance mode with the chamber **12** and obtain a first working frequency band. In the first exemplary embodiment, the first working frequency band is the GPS frequency band or the WiFi 2.4 GHz. The antenna **30** can be supported by a base formed by screen glass or an antenna carrier or the like.

In this exemplary embodiment, the dimensions of the chamber **12** are about 50 mm×10 mm×8 mm. The dimensions of the radiating body **33** are about 9.8 mm×3 mm. The width of the first gap **39** is about 0.2 mm.

In other exemplary embodiments, the chamber **12** can be entirely formed within the housing **10** and also can be cooperatively formed by the housing **10** and other metal member such as a metal rear cover of the screen **11**, a system ground plane, a metal shield, or a metal plane.

FIG. **3** is a schematic view of a wireless communication device **200**, according to a second exemplary embodiment of the disclosure. The wireless communication device **200** is substantially similar to the wireless communication device **100**. The wireless communication device **200** includes a housing **10** and antenna **50**. The antenna **50** includes a radiating body **53**, a feed end **55** and a ground end **57**.

The difference between the wireless communication device **200** and the wireless communication device **100** is that the radiating body **53** of the wireless communication device **200** is substantially L-shaped. The radiating body **53** includes a first radiating section **531** and a second radiating section **533** perpendicularly connected to the first radiating section **531**. The feed end **55** and the ground end **57** extend from an end of the first radiating section **531** opposite to the second radiating section **533**, and are parallel and spaced from each other. The second radiating section **533** defines a second gap **59** with one of the second side walls **125**. The other structures of the wireless communication device **200** are substantially similar to the wireless communication device **100**.

In the second exemplary embodiment, the dimensions of the chamber **12** are about 50 mm×10 mm×8 mm. The dimensions of the radiating body **53** are about 9 mm×7.6 mm. A width of the second gap **59** is about 1 mm.

FIG. **4** is a schematic view of a wireless communication device **300**, according to a third exemplary embodiment of the disclosure. The wireless communication device **300** is substantially similar to the wireless communication device **100**. The wireless communication device **300** includes a

housing **10** and antenna **60**. The antenna **60** includes a radiating body **63**, a feed end **65** and a ground end **67**.

The difference between the wireless communication device **300** and the wireless communication device **100** is that the radiating body **63** of the wireless communication device **300** is substantially T-shaped.

The radiating body **63** includes a first radiating section **631** and a second radiating section **633** perpendicularly connected to a middle portion of the first radiating section **631**. The feed end **65** and the ground end **67** extend from an end of the first radiating section **631** opposite to the second radiating section **633**, and are parallel and spaced from each other. The second radiating section **633** defines a third gap **69** with one of the second side walls **125**. The other structures of the wireless communication device **300** are substantially similar to the wireless communication device **100**.

In the third exemplary embodiment, the dimensions of the chamber **12** are about 50 mm×10 mm×8 mm. The dimensions of the radiating body **53** are about 12 mm×8.2 mm. A width of the third gap **69** is about 1.7 mm.

FIG. **5** is a schematic view of a wireless communication device **400**, according to a fourth exemplary embodiment of the disclosure. The wireless communication device **400** is substantially similar to the wireless communication device **100**. The wireless communication device **400** includes a housing **10** and antenna **70**. The antenna **70** includes a radiating body **73**, a feed end **75** and a ground end **77**.

The difference between the wireless communication device **400** and the wireless communication device **100** is that the radiating body **73** of the wireless communication device **400** is substantially rectangular. The feed end **75** and the ground end **77** are extended from one side of the radiating body **73**, and are parallel and spaced from each other. A slot **731** is formed between the feed end **75** and the ground end **77**. The radiating body **73** defines a cut **733** at one end of the radiating body **73** adjacent to the ground end **77**. The radiating body **73** defines a fourth gap **79** with one of the second side walls **125**. The other structures of the wireless communication device **400** are substantially similar to the wireless communication device **100**.

In the fourth exemplary embodiment, the dimensions of the chamber **12** are about 50 mm×10 mm×8 mm. The dimensions of the radiating body **73** are about 16 mm×8.1 mm. A width of the fourth gap **79** is about 1.9 mm.

The curves S**51**, S**52**, and S**53** shown in FIG. **6** represent return loss of the antennas **30**, **50** and **60** which are shown in FIGS. **2-4**, respectively. According to test results shown in FIG. **6**, each of the wireless communication devices **100**, **200**, **300** can work at a frequency band of Bluetooth/WiFi 2.4 GHz.

The curves S**61** shown in FIG. **7** represent return loss of the wireless communication device **400** when the antenna **70** is positioned above a central portion of the chamber **12**. The curves S**62** represents return loss of the wireless communication device **400** when the antenna **70** is positioned away from the central portion of the chamber **12** and is positioned at a position having a distance about 0.5 mm from the first side wall **123**. According to test results shown in FIG. **7**, the wireless communication **400** also can work at the frequency band of Bluetooth/WiFi 2.4 GHz/5 GHz.

The antennas **30**, **50**, **60**, **70** are coupled with the chamber **12** to function when able to resonate with the chamber **12** and obtain the necessary frequency bands. Thus, the housing **10** does not need to have a non-metal portion and can have an integrated metal appearance.

It is believed that the exemplary embodiments and their advantages will be understood from the foregoing description, and it will be apparent that various changes may be made thereto without departing from the spirit and scope of the disclosure or sacrificing all of its material advantages, the examples hereinbefore described merely being preferred or exemplary embodiments of the disclosure.

What is claimed is:

1. A wireless communication device, comprising:

a housing, the housing defining a chamber, the chamber comprising a bottom wall, two opposite first side walls, and two opposite second side walls connected to the first side walls, the first side walls and the second side walls surrounding the bottom wall; and

an antenna, the antenna comprising a radiating body, a feed end, and a ground end, the radiating body suspended above the chamber, the feed end and the ground end extending from the radiating body and connected to one of the second side walls, the feed end and the ground end being in parallel, a length of the feed end being slightly shorter than that of the ground end, the radiating body, the feed end and the ground end being coplanar;

wherein the feed end and the ground end are both perpendicularly extended from one end of the radiating body; the feed end, the radiating body, the ground end and the second side wall cooperatively enclose a close slot.

2. The wireless communication device of claim **1**, wherein the radiating body is substantially rectangular.

3. The wireless communication device of claim **2**, further comprises a connection member, wherein the feed end is connected to one of the second side walls by the connection member, the ground end is directly connected to the one of the second side walls, another end of the radiating body defines a first gap with the other of the second side walls.

4. The wireless communication device of claim **1**, wherein the radiating body is substantially L-shaped and comprises a first radiating section and a second radiating section perpendicularly connected to an end of the first radiating section.

5. The wireless communication device of claim **4**, further comprising a connection member, wherein the feed end is connected to one of the second side walls by the connection member, the ground end is directly connected to one of the second side walls, another end of the radiating body defines a second gap with the other of the second side walls.

6. The wireless communication device of claim **1**, wherein the radiating body is substantially T-shaped and comprises a first radiating section and a second radiating section perpendicularly connected to a middle portion of the first radiating section.

7. The wireless communication device of claim **6**, further comprising a connection member, wherein the feed end is connected to one of the second side walls by the connection member, the ground end is directly connected to one of the second side walls, another end of the radiating body defines a first gap with the other of the second side walls.

8. The wireless communication device of claim **1**, wherein the radiating body is substantially rectangular sheet, the radiating body defines a cut at one end of the radiating body adjacent to the ground end.

9. The wireless communication device of claim **8**, wherein one side of the radiating body opposite to the feed end and the ground end defines a fourth gap with the other of the second side walls.

10. A wireless communication device, comprising:

a housing, the housing defining a chamber, the chamber comprising a bottom wall, two opposite first side walls, and two opposite second side walls connected to the first side walls, the first side walls and the second side walls surrounding around the bottom wall; and

an antenna, the antenna comprising a radiating body, a feed end, and a ground end, the feed end and ground end extending from the radiating body and connected to one of the second sidewalls, the antenna coupled with the chamber by the feed end and the ground end to activate resonation modes and obtain a corresponding working frequency band, the feed end and the ground end being in parallel, a length of the feed end being slightly shorter than that of the ground end, the radiating body, the feed end and the ground end being coplanar;

wherein the feed end and the ground end are both perpendicularly extended from one end of the radiating body; the feed end, the radiating body, the ground end and the second side wall cooperatively enclose a close slot.

11. The wireless communication device of claim 10, wherein the radiating body is substantially rectangular.

12. The wireless communication device of claim 11, further comprises a connection member, wherein the feed end is connected to one of the second side walls by the connection member, the ground end is directly connected to the one of the second side walls, another end of the radiating body defines a first gap with the other of the second side walls.

13. The wireless communication device of claim 10, wherein the radiating body is substantially L-shaped and comprises a first radiating section and a second radiating section perpendicularly connected to an end of the first radiating section.

14. The wireless communication device of claim 13, further comprises a connection member, wherein the feed end is connected to one of the second side walls by the connection member, the ground end is directly connected to one of the second side walls, another end of the radiating body defines a second gap with the other of the second side walls.

15. The wireless communication device of claim 10, wherein the radiating body is substantially T-shaped and comprises a first radiating section and a second radiating section perpendicularly connected to a middle portion of the first radiating section.

16. The wireless communication device of claim 15, further comprises a connection member, wherein the feed end is connected to one of the second side walls by the connection member, the ground end is directly connected to one of the second side walls, another end of the radiating body defines a first gap with the other of the second side walls.

17. The wireless communication device of claim 10, wherein the radiating body is substantially rectangular sheet, the radiating body defines a cut at one end of the radiating body adjacent to the ground end.

18. The wireless communication device of claim 17, wherein one side of the radiating body opposite to the feed end and the ground end defines a fourth gap with the other of the second side walls.

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